variety of situations made at intervals throughout more than a year indicate that the silk net retains from one-half to one forty-fifth of the total solid contents of the water, the greater losses occurring from waters containing *Trachelomonas*, *Chlamydomonas*, *Euglena*, *Melosira* and other minute forms in abundance. The relative amount of silt is, however, much greater in the filter-paper catches than it is in those made with the silk, so that the actual volume of plankton lost is less than the above figures indicate. The amount escaping through the silk bears no constant relation to the amount retained. Under these conditions the volumetric determination of the plankton by the use of the silk net as a test of the productiveness of water is not only incomplete but may be misleading.

For the examination of the plankton by the statistical method the silk affords a satisfactory basis only for the larger forms, such as the *Entomostraca* and the larger *Rotifera* and *Protozoa*. For the smaller and often very abundant planktonts, such as *Melosira*, *Peridinium*, *Dinobryon*, *Raphidium*, *Scenedesmus Euglena*, *Trachelomonas* and *Chlamydomonas*, the Hensen method is wholly inadequate. For example, from water in which these smaller forms were not extremely abundant the silk retained organisms to the number of 248,200 per cubic meter, while the catch of the Berkefeld filter indicated the presence of 767,556,000 planktonts in the same amount of water. Many of the organisms listed in the counting tables of Apstein may in reality escape in large numbers through the silk. Thus, of *Codonella* as many as *twenty-one* individuals may escape to *one* retained. The Hensen method must be supplemented by a more accurate system of collection if a complete census of the water world is to be taken.

From the œcological point of view the plankton lost by leakage through the silk s of prime importance, for it is composed very largely of minute algæ, which constitute a fundamental link in the cycle of aquatic life. Any attempt to unravel the complex interrelation of the constituents of the plankton or to correlate its ever-progressing changes with the factors of its environment must be based upon reliable data. Biological theory and aquaculture alike demand improvement in the plankton method.

The errors enumerated above are doubtless exaggerated by the situation with which we deal—waters rich in plankton and more or less turbid with silt. The tests, however, cover a considerable seasonal and local range of quantity and constituency, and have been made in both clear and turbid waters. The plankton, moreover, is composed very largely of the same genera as those found in the lakes in which Apstein and Zacharias have carried on their investigations, and over 50% of the species are identical. The desirability of experiments in other waters is at least suggested.

C. A. Kofoid.

Illinois Biological Station.

SOUTHERN STAR-CLUSTERS.

The last of the great contributions of Benjamin Apthorp Gould to astronomy is contained in the large volume recently published under the title *Cordoba Photographs: photographic observations of star-clusters from impressions made at the Argentine National Observatory*. This work gives the measurements of the relative positions of nine thousand stars included in thirty-five clusters of the southern heavens and in the Pleiades and Præsepe.

In addition to the other large enterprises which constituted the regular work of the Argentine Observatory, over twelve hundred plates of southern clusters were secured (no important one being omitted) in the decade beginning in 1872, of which 281 have been measured and 177 are now computed. Inasmuch as the dry plate pro-

cess was not available until more than one half of the plates had been secured (in 1881), the serious character of the task of merely obtaining the photographs, with all the difficulties of the wet process, is sufficiently apparent. But this labor was small relative to that of the subsequent measurements and computations, which were carried out rigorously in all respects during the past fifteen years. As for the work at the micrometer it is stated that two assistants, alternately measuring and recording, could ordinarily measure from thirty to thirty-five stars a day.

It is, indeed, unfortunate that it was necessary that so long a time should elapse before the publication of the results, for it has delayed the recognition of Dr. Gould's position as the leading pioneer in the application of photography to astronomy of precision. It should be recalled that it was necessary for him to solve for himself, or with the coöperation of his friend, Lewis M. Rutherfurd, most of the difficulties of adjustment, measurement and computation, which have since engaged the attention of frequent congresses of the committee of the *Carte celeste*. It was as early as 1866 that Dr. Gould presented to the National Academy his memoir on the reduction of photographic observations, with the determination of the position of thirty-nine stars in the Pleiades, from measures by Rutherfurd on plates he had taken. It is much to be regretted that the publication of this memoir did not occur until twenty years later.

On going to Cordoba in 1870 Dr. Gould carried with him the photographic object-glass which Rutherfurd had so successfully used, but to his dismay he found it had been broken on the voyage. Thus the work was delayed three years, although a hundred plates were obtained with the mended objective, then replaced by a new one. Two exposures, of about eight minutes, were made upon each plate, a slight shift in right ascension intervening, so that defects on the plates could be distinguished from stars; then a third exposure gave either a trail or one point of the trail before the star left the photographic field of view, whereby the orientation of the plate could be determined. Of course, great difficulty was found in securing accurately circular images, especially as the modern plan of a large guiding telescope was not employed, but 'plates not satisfactory in this respect were summarily rejected without hesitation, no record being made of them, or numbers assigned.'

The measurements were carried out with two micrometers constructed by Rutherfurd and used by him in his early work. The coordinates measured were position-angle and distance, referred to some selected star as center. In some cases, of large clusters, several centers were employed, but the final positions are in all cases reduced to differences of right ascension and declination ($\Delta\alpha$ and $\Delta\delta$) from a single central star. As each plate contained some stars whose position had been determined with a meridian circle, the comparison of the catalogue and photographic coordinates furnished equations of condition from which corrections were applied to the latter. The accordance of the separate determinations of $\Delta\alpha$ and $\Delta\delta$ on different plates is highly satisfactory, and is not exceeded in recent measurements of clusters by other astronomers provided with telescopes and measuring micrometers of the latest design. Were such confirmation longer necessary, the reliability of the photographic method would be sufficiently established by the results of this volume.

Dr. Gould expresses the 'fear that trustworthy inferences from stellar photographs may not be expected in the present condition of science and the photographic art,' and hence does not attempt to utilize the photographs for photometric purposes, although approximate magnitudes are as-

signed and discordances noted. It may be, however, that the plates will later prove more useful than was anticipated in this direction. Certainly a comparison would be interesting with the Harvard Arequipa plates, on which Bailey has detected numerous variable stars, and the periods of some might thereby be accurately fixed.

A chapter of the work, in parallel Spanish and English, is devoted to each cluster, furnishing all the necessary data of measurement, the relative positions, and comparison with other, visual, measures where existent. Excellent charts are given of all the clusters. At the time of the lamented death of Dr. Gould, a year ago, one-half (pp. 248) of the volume had been printed, and the computations of the remainder were practically complete. But the unfinished portion of the manuscript has been carefully prepared after the original plan by Mr. G. E. Whitaker, to whom Dr. Gould makes acknowledgment for ten years of efficient service, under the general supervision of Dr. S. C. Chandler, and the whole volume may be fairly 'regarded as coming complete from the hand of its author.'

Edwin B. Frost.
Dartmouth College.

CURRENT NOTES ON PHYSIOGRAPHY.

THE ASSAM EARTHQUAKE OF JUNE, 1897.

A report on the earthquake of June 12, 1897, in the Province of Assam has lately been published by the government of India in the form of a number of letters from local officers, English and native. The shocks occurred in the Khasi hills, famous as the district of the heaviest known rainfall; they are ascribed to faulting, entirely independent of volcanic action, of which there was no trace. Many ancient monolithic monuments were broken, or even torn out of the earth; their previously undisturbed condition being taken as evidence that no such earthquake had visited the region since their erection. In many villages the heavier houses were thrown down or badly injured, and had not most of the inhabitants been out of doors after a rainy morning the loss of life would have reached a greater number than is now reported, 1542. Among the hills much damage was done by landslides occasioned by the shocks; hillside paths were thus carried away, villages destroyed, and many people killed in the valley fields. In the plains to the south many deep cracks and crater-like pits were opened. One of the cracks was a mile long, two or three feet wide and 16 feet deep. Two persons lost their lives by being engulfed in such cracks. The pits average six feet in diameter and are spread around with sand that was thrown out by jets of water. In the Sylhet plains, traversed by numerous water courses, most of the villages are on the belt of higher floodplain close to the streams, and there much loss was caused by the slipping of the banks into the channels. Cholera and fever followed the earthquake, by reason of the disarrangement of water supply and drainage.

THE MOODUS NOISES.

A correspondent of the New York *Sun* states that the "famous and mysterious disturbances of the lower Connecticut valley, the 'Moodus noises,' are being heard again" after a silence of twelve years. The Indians knew of them before the coming of white men. For twenty years, up to 1729, the villagers thereabouts heard the noises almost continuously, 'shaking the houses and all there is in them.' They were again heard in 1852 and 1885. On the recent recurrence there was a sound like a clap of thunder, followed for some two hours by a roar like the echoes of a distant cataract. A day later there was a crashing sound like heavy muffled thunder, and a roar not unlike the wind in a tempest. The ground was shaken, causing houses to